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inch per annum is at least only one-third of the average rainfall, which would give us a total average rainfall of 4 inches per annum over the area of this geographical basin; and as we know that in every country in the world a portion of the rainfall (estimated variously from one-third to one-twelfth) percolates and is absorbed by the soil and the permeable strata, and that the whole of this basin is elevated much above the sea-level, and that according to tradition the Helmund formerly discharged itself into the Indian Ocean, there is room for a strong inference in my opinion that a vast body of water is available, in the whole of that region between the 30th parallel of latitude and the sea. It is recorded by navigators that large springs of fresh water burst up through the sea in the neighbourhood of Cape Ormuz; the same thing has been observed off Cape Monge; and I doubt not if attention were called thereto the same phenomenon would be observed in other parts of the coast. The formation of this part is undoubtedly tertiary, and the stratification of the hills where not horizontal generally inclines either to the eastward or southward. It will be recollected that under somewhat similar conditions the French engineers a few years since have brought a perennial flow of water in many parts of the Algerian Desert.

I regret that I have felt it necessary, in order to attempt to convey my ideas and information on this very interesting subject, to have been led into such a lengthy paper, and should it have no better effect than to excite inquiry and attention to this subject, I shall consider the labour I have bestowed amply repaid.

XVIII.—*Notes on the Pangong Lake District of Ladakh, from a Journal made during a Survey in 1863.* By Capt. H. H. GODWIN-AUSTEN, F.R.G.S., Topographical Survey.

Read, December 10, 1866.

To the north of the Indus, from its junction with the Dras River, lies a high range of mountains which separate the Indus drainage from that of the Shayok or Nùbra River. The axis and great mass of this range is granitic; on the west this extends to within a very short distance of the river, while at Pitùk below Leh, the granitic hill on which that large and well-known monastery stands abuts on the Indus itself, and thence towards the east for a considerable distance it holds the same position. The great mass of coarse sand-stones, red clays, grits, and conglomerates, seen on the right bank of the Indus, west of Pitùk, are now seen on the left or south bank, thence to the

east in the direction of Stock and Himis. On the above granite range are several passes leading into the Shayok Valley, all of great elevation; and on the direct road from Leh to the Pangong Lake are two, viz., the "Chang La," and the "Kay La," both high, being respectively 17,470 and 18,250 feet above the level of the sea.

The ascent to the first is gradual from the village of Tagar in the Chimray Valley, which there divides into two large ravines; the western branch leading to the Wari La, while the eastern runs up to the two passes above mentioned. On the 15th July, when our party crossed the Chang La, the snow that had fallen in the early part of the month still lay; we all suffered more or less from the effects of the rarified air. On the return journey *viâ* the Kay La, 800 feet higher, scarcely a man suffered from this cause: we had then been living for some time at a high altitude, which very probably had not a little to say to our immunity from the fatigue and headache engendered at high elevations. The mountains on the northern side are perfectly bare, a little grass growing only along the bottom of the valley, which had a steady easy slope the whole way to Dürgo, and the scenery is not remarkable save for its huge scale and bleakness. Before reaching the village of Dürgo, one emerges out of the narrow valley upon the level surface of one of those large accumulations of alluvial sands and shingle that are seen along the large valleys of these mountains. The powerful force that accumulated the materials that form them is now extinct, and the circumstances attending their formation, and, more wonderful, their subsequent denudation, are as yet but little understood. At this spot the vast scouring process was well exemplified: the level of the plateau on which I stood could be traced across the valley in and out of its numerous ravines in a perfectly horizontal line of a different colour, where very small portions of the alluvium still adhered to the slopes and precipices; and I do not think I am exaggerating when I state that its thickness at the junction of the streams below Dürgo was over 1500 to 2000 feet. The whole valley is very open—low cliffs of alluvial sands and clays can be traced the whole distance on both sides—and it is self-evident that at no very distant period this presented a long reach of water; an after sojourn on the Pangong fully confirmed this.

From Dürgo to Tanksè is a distance of 8 miles, and the road quite level. The stream is considerable, and contains a small kind of fish, of which I saw numbers at the Dürgo bridge. Mountains rise to a great height on either side; and at the southern end of the valley, towering above Tanksè, is a fine snowy peak, called Tanksè No. 1. The village of this name is

large, and a very fair area under cultivation. Many of the houses are built close under a large mass of conglomerate, the stones firmly cemented in it, and to this cause it must owe its present existence at the mouth of the narrow gorge towards the Pangong, out of which the soft beds have been washed away. The main stream comes from the southward, and drains the Lũng Yũghma Valley and the mountains on the north of the Indus River. It is joined at Tanksè by the small stream that drains the valley up which the road to the Pangong runs; this is at first rather shut in and confined by the mountains that rise in cliffs on either hand, but where it takes the more direct easterly direction it opens out considerably; high cliffs of the alluvial shingly deposits again occur, forming a belt at foot of mountains of the northern side, about 300 feet high, and some 400 yards distant from the stream. The physical appearance of the whole length of this valley showed unmistakable signs of its having at one period been the bed of a lake. I am induced to think for a part of that time it was continuous with the portion below Tanksè, and that the mass of alluvium above Dũrgo was contemporary with that above Mũglib. Above the two lakes, Tragũmè Bur Tso, there is no longer any water in the bed of the stream save at intervals here and there, where it breaks out in a small rill to lose itself in the loose gravel a few yards lower down. Over distances of more than a mile it is deep white sand, the collection of which is a good deal due to the wind. Down to this sand the talus from the mountains extends, tending every year to increase the height of level. At the low pass of Surtokh, whence one obtains the first view of the Pangong Lake, this action is nowhere so well seen; this ridge of Surtokh forms the watershed across the natural exit for the waters of the great lake, and it is entirely formed by the loose shingle brought down a somewhat large lateral ravine from the snowy peaks to the south. This bed of talus actually divides, part to the eastward, part to the west, so that the waters may in some years blow one way, in others another. If the supply of water to the Pangong Lake were equal to what it must formerly have been, when the glaciers were double their present size, the continual flow of water would soon carry off these talus accumulations from the mountains above Surtokh; there being now no force in action for this purpose, the snows of winter and the waters of the side ravines tend to raise the main valley-level every year.

The Pangong Tso (lake) is about $2\frac{1}{2}$ miles distant from the low ridge of the Surtokh La, or, more properly speaking, its natural bar or bund, but the level of the old lake-bed extends up to within a very short distance of the pass. A rise of 150

feet in the waters of the present lake would find them again an exit down the valley to Tanksè. A trigonometrical station lies close to the water's edge; its height has been determined trigonometrically to be 13,931 feet above the sea. From this mark-stone a fine view of the first long reach of this elevated and interesting piece of water is obtained. Its colour is of an intense blue, the water as clear as crystal, but far too saline to be drinkable; there was quite a salt-water feel in the air as the wind blew off it. Knobs and peaks were seen for many a mile along the spurs that descended from the ranges bounding the northern shores. From the height at which one stood, these all appeared comparatively low, only on the highest lay a few small patches of snow, thence to their bases was one succession of shades of yellows, purples, reds, and browns, the invariable colouring of Tibet, not a scrap of green.

The Pangong Hill Survey Station is a short easy pull of some 1000 feet above the lake, obtaining a most commanding view, up and down it, across the spurs of north bank and high up among the snowy peaks to the south, where small glaciers just show above the masses of the old moraines, which extend down to the level of the lake. Little streams flow down these steep inclines, like silver threads, from the ends of these glaciers, to finally lose themselves in the silt and sands that skirt the edge of the lake, for only the most considerable of these streams find an exit in its waters. Such is the one that flows through the little oasis of Mun; it owes its size to the streams from three glaciers, uniting some distance above the village. The silt brought down by these has formed a miniature delta, or arm of shallow water running out into the lake. In the course of a conversation with the coolies and men of Mun, I learnt that, some three or four marches on, the lake narrowed to a mere stream which was fordable, and that it was not necessary to follow the northern shore. On the 22nd July my march lay over the sandy, stony plain, skirting the shore of the Pangong, crossing two or three ravines, where sections are well displayed of former and higher levels of its waters, in sands interstratified with an angular rubble like that distributed over the present surface. At about 8 miles from Mun, the straggling village of Mèruk is passed on the right hand, and the last on the lake—Karkpèt—is 3 miles further. The level ground between the shores and the foot of the mountains increases much in breadth as one proceeds east, and the stream from Chushal gives from a distance no signs of its proximity; and I was rather surprised on coming suddenly upon a fine body of water, flowing with a quiet current through a narrow belt of green grass, some 10 feet below the surface of the plain. Finding plenty of wood and a

nice green sheltered spot under the bank, I pitched camp by the side of it.

The extent of level ground here is considerable, quite 10 square miles, dotted over in the vicinity of the stream with a few low bushes, and over the rest grows a scanty coarse grass in tufts. Towards the shore of the lake rise two very conspicuous isolated low rocky knobs, a mile apart, and between these is the confluence of the Chushal stream and the Pangong Tso. The next morning I walked across and ascended the most eastern eminence, having the strange sounding name of Tuggù Nuggù. This had formerly been a fortified post; the level space at the top was enclosed by a low stone wall, while a detached outwork had been built on the low spur that ran out on the east side: none of my coolies, who were all from this district of Pangong, could give any account of it, as to when or by whom it had been built. It must be comparatively an ancient work; still, considering how soon events are forgotten by such men, its age may be only 150 to 200 years. It was a lowering morning, and, before I had finished my survey work from this position, it came on to rain hard, which we sat out on the top. The shower passed off up the lake; and it had a fine effect on the view in that direction, with the lines of falling rain over the expanse of water and the misty mountains bounding its sides. The state of the plain, which, when dry, is covered with a hard incrustation of lime and a salt that crackles under the feet, had now by the wet been turned into a sticky loam, that adhered to the boots in huge lumps and remained like a cement upon everything it came in contact with. One and a half mile beyond Tuggù Nuggù low spurs abutt upon the lake in cliffs of 150 to 200 feet high, and the way leads along the narrow shore at their foot, with very deep water washing the bank. Passing one large bay we rounded a low narrow point of beach only to find the existence of another bay, called Phûrsook; this forms the boundary between the Kashmir Rajah's territory and the Chinese district of Rudokh.

Phûrsook formed a circular, sheltered little lake in itself. A narrow strait only connects it with the water outside. It was evidently of great depth in places where the hills came down in cliffs upon it; a narrow beach ran along the foot of these, formed of talus cemented by lime. The bay formed a perfect harbour, in which a line-of-battle ship might have floated, and sailed in and out of it. Were this lake in a less elevated region, or on a line of trade, how useful would the water-communication prove up and down the extent of its two long portions. The first or lower lake is 40 miles in length, the second 33; giving a total of 73 miles, exclusive of the upper long portion beyond Tso

Nyak, which is quite 18 miles. The first thing that must strike any one of observation, is the evidence of this lake having been formerly fresh for its entire length. Myriads of dead fresh-water shells now strew the shore. These, thrown up by the waves in a long white ridge, lie so thick in some of the bays, they can be taken up in handfuls. They are principally of *Lymnæa* and *Planorbis*; but, though I searched diligently, I never found a large bivalve—only one very small *Pisidium*, that I found inside one of the specimens of *Lymnæa*: nor did I ever find a living specimen, which I had hoped to do in the upper lakes, where the water was very slightly brackish. When these shells existed, the former lake must have had quite a different aspect from its present one; and in it must have grown, for the sustenance of these molluscs, beds of water-plants, while its banks would have been fringed probably with grass and rushes.

There is a point in the history of the Pangong Lake on which may be based a good deal of theory as to its older aspect: it is the former size and extent of its waters. On every side unmistakable traces that the level was much above the present one are seen in the lines of old beaches and in the beds of sand, containing the fossil remains of fresh-water shells, interstratified with beds of angular *débris*, which, as I mentioned before, are to be seen in the little dry ravines that cut through the plain.

These sections prove great changes, and also, I think, that the lake existed prior to, certainly during the latter part of, the great glacial period in the Himalayas. Whether the scooping out of the depression in which its waters lie is due to glacial action in the first instance, when this high region was, as is most probable, deeply overlaid by ice and snow, is a hazardous question, and one highly problematical. From the alternation of the beds of *débris* and finer deposits, we can infer that there have been milder and moister seasons than at present exist, back to colder and drier: during the first, beds would have been deposited by the increased transporting power that would have carried the materials further out into the lake, while at the same time the level of the waters would naturally have been much higher. Its waters must then generally have held much silt and mud in suspension to form the shell-beds already mentioned. At the present day no deposit of any kind is taking place, save perhaps near the débouchement of the Chushal and the extreme western tributaries.

A closer inspection, with some levelling, would, I think, somewhat clear up the mystery attached to the huge masses of alluvial deposits seen in the valleys of all the great rivers of the western Himalayas, from the Chang Chingmo and Leh to Skardo, in the Valley of Kurgyl and Valley of Dras, and on both the

Thelum and Chandrabagha (Chenab) rivers. Give a greater rainfall to the Pangong district, and a lower snow-line, now above 20,000 feet, and the ravines would be seen with fine running streams in them, and, allowing time, would cut through the barrier at the Surtokh La, and eventually down through the whole length of the alluvial deposits in this lake-basin; the large valley and its tributaries then drained would resemble most closely on either side the sand, shingle, and conglomerate deposits now seen at Tanksè and on the above-named rivers. These deposits at Ote would be somewhat higher, and would cover a greater area from the junction of the great tributary there. As a proof that the waters of the Pangong Lake in former times have fallen below its present level, I may state that on a long point of land in the little Bay of Phürsook, in deep, very clear water, I looked down upon a terrace 10 feet below the surface, which terminated in a cliff, where the stratification of the sand and clay could be well seen; the bottom was not visible beyond this, and it was too far out to enable me, with my present means, to sound the depth. The only deduction to make from such comparatively recent changes is, that the level of its waters has been alternating with moist and dry periods of time, the slow process of which may be even now going on almost imperceptibly to man. The water of the Pangong, depending, as it does, mainly on the winter snow, I ask, may not the snowfall in this part of the Himalayas be much less now than formerly, and the country passing through a period of diminishing falls? Slow as such changes may be, they are by no means improbable or impossible. From the mountain-spurs having approached so close to the broad bed of the Kyam go Tragger, the absence of water, and it having also taken a bend, we had been led to imagine its course here ended; but this we were both of us much surprised to find was not the case, for we now beheld ahead of us an enormous gravel-covered valley, stretching away to the foot of mountains at least 18 miles further to the eastward. This open valley had the most peculiar aspect of any I had yet seen, but partook in its dry gravelly bed a good deal of the nature of those valleys I had seen between Pal and the Kiüng Gang La; its elevation was about 16,400 feet, and its breadth in widest part about 2 miles, the ridge of hills bounding it to north, lay to about 4 to 5 miles off, but were only 3000 feet above it, and the spurs came with a very gradual fall towards the valley. On the south a very low ridge of about 500 feet—in places not more than 300—separated this valley-plain from another broad one of a like character, the ravines of which ran up into the hills in wide beds, from 200 to 300 yards in breadth. Several broad lateral drainage-plains

also formed a junction with the one we were in, from the northern line of hills that run parallel with it.

In the foregoing pages reference has been made to the great accumulations of boulders, gravels (more or less angular), clays, and sands, near Tankse, and in the Chang Chùngmo; it is necessary to add a few words regarding the cause I assign to their formation. This I think clearly glacial. Proofs are not wanting that in ages past the valleys of the Himalaya contained glaciers of enormous length and thickness, the only types of which are to be seen in those now filling the valleys of the Karakoram, far north in Baltistan. About half-way between the villages of the Kungun and Gond, lying on the Lind River (a tributary of the Jhelum), Kashmir, and at the village of Gond itself, marks of glacial action are unmistakable in the deep grooves or striæ cut in the hard metamorphic slates, at a height of 150 to 200 feet above the present level of the river. This point is 20 miles in a direct line from the head of the valley, where at present some very small glaciers exist. How much further this glacier extended towards the plain of the Kashmir Valley it is impossible to say, but at the débouchement, 10 miles below, thick beds of *débris* are to be seen. The Sind River is still of very considerable size, and glacial accumulations are very soon swept away, as may be seen in the now existing large glaciers below their terminal cliffs. Taking 5500 feet as the lowest limit of its extension, every valley in the vicinity of a range equal in mean altitude to the mountains north of Kashmir, must have been once the bed of these moving rivers of ice. The indication of glacier extension are also seen on the north of the Zogi La, between the present glacier of Muchoi and Pundras, at 10 miles from the pass. It is my belief that the Dras plain was once buried in ice, and that this region presented much the same appearance that the neighbourhood of the Mustakh does now. The imagination can hardly conceive the enormous magnitude that glaciers like those in the Karakoram must have once attained, and that they extended into the Skardo Valley on the Indus; 70 to 80 miles is by no means improbable. Smaller ones from the ridge to the south we know did; for near Kephün, a fine mass of moraine protrudes into the plain nearly a quarter of a mile, having very large angular blocks on its surface. Moreover, this moraine must have been formed after the valley around Skardo had assumed somewhat its present configuration, for this basin has at some period been filled up with beds of lacustrine deposit, gravels, and conglomerates, to a height that overtops the present isolated rock rising above the town, the coarser beds being the highest in the series; but it is quite natural to suppose that on a milder climate succeeding,

these larger alluvial deposits would be the first to be removed by the extinction of glaciers further down the valley, while the cold was yet intense enough to preserve those around and above Skardo. Though the vast accumulations of *detritus* in the Skardo basin were, I conceive, due to the glaciers from the high ranges both to the north and south of the Indus near Basho, which glaciers must have extended close down to and dammed up the river, it does not follow, as some might be led to suppose, that the whole mass of such a mighty barrier should be formed of ice. It was the *débris* of moraines that would have composed this, from its continued accumulation in so narrow a gorge as the Indus there presents. These exuviae piled up would have raised the bed of the gorge, and the bed of the lateral valley as well, also elevating the active cause, viz., the glacier itself; and in course of time the whole valley-level would have been brought up to the height of the great deposits around Skardo. Innumerable other instances can be seen of ice-action throughout the Kashmir territory. I will instance near the Fotu La, on road to Leh, a spot now far removed from such causes in action. Even in the valley of the Jhelum, below Bara Mûla, the effects of a glacial period can be seen. That glaciers, filling lateral ravines, have extended across the main valleys at some period of their existence is most probable; and in nearly every case where gravel deposits are seen, some side ravine below, having its sources high up, can be pointed out, whose glacier has formed a temporary stoppage to the main river into which it ran; and such effects are still in progress in the highest ranges of the mighty Himalayas. When glaciers extended down to 5000 feet, what must have been the appearance of the Upper Shayok Indus and Chang Chûngmo, where 12,000 to 13,000 is the lowest level of the country? Contemplation of such a condition renders the formation of lakes and the accumulations of detrital matter a natural sequence, very easy to imagine. Further, when such powerful forces of ice and water were in action, their results would have extended far down the main-drainage lines, and are to be sought for at the débouchement of such rivers as the Indus, the Sutlej, Ganges, &c.; and I believe that the more recent accumulations of immense boulder-beds composed of rocks from the inner ranges, such as may be seen in the Noon Nuddee, Deyrah Dhoon, and other places along the base of the Himalayas, may owe their existence to a glacial period in these mountains.

In the lower lake there is not a vestige of any sort or kind of plant. The beautifully blue clear water washes a bank of sand and pebbles, the latter perfectly free from algæ. This is not the case beyond Ote, where the water is much less salt;

there the stones under water are extremely slippery, and covered with vegetable growth. At this part, also, patches of a coarse water-weed are also seen here and there along the shore, but not growing luxuriantly, and evidently making a struggle for existence. The waters of the western end are far more salt than those of that near Ote, noticeable even to the taste, but it is not until the stream that connects the two portions is fairly entered that it is by any means drinkable; thence for the whole distance eastward we used to take water, save when we had the luck to find a spring of really fresh. By looking out carefully we discovered springs in three places flowing out from under the bank, and in one spot these springs were bubbling up for some distance out into the lake, rendering the water quite fresh around; and it was quite a pleasure to see the poor yâks, who carried our baggage, take a fill of it, when for three days they had drank nothing but salt water. A curious feature of the Pangong is the almost entire absence of streams whose waters find an exit in it, considering the great area that some of them drain; for, with the exception of the few glacial rills and the Chushal stream on its south shore, and the stream at the extreme west end, from the Marse Mik La, there are none. The northern shore is particularly dry; not a single rill joins it for its entire distance until arriving at "Pal," on the upper lake; and the same may be said of the southern shore, from the Chushal River to Ote, and for many miles beyond. Many of the ravines have their sources at a considerable distance, but near the lake have broad dry beds from 200 to 300, and up to 500 yards in breadth of rubble and sands. I may instance the very large lateral ravine at Ote, the longest branch of which runs back into the snowy mountains of Chang Chûngmo for a distance of 40 miles, draining altogether an area of nearly 400 square miles. The silt, which in former times has been carried down from the above area, has formed the plain of Ote, the broad barrier to what would otherwise be a continuous long reach of water. This was no doubt the old configuration of the lake, for a rise of some 12 feet would cover the greater part of the Ote plain even now. In nearly all the higher ravines water is plentiful, and glaciers of the second order are seen, but the streams are all sopped up in the broad bed of the main valley, which acts like a perfect sponge: the stream breaks out occasionally here and there only to hide itself a few hundred yards down; the last water seen being above the fort of "Lanakh-khur," but it nowhere is seen to flow into the lake, being lost in the sands of the plain.

The western end of the Pangong Tso lies, as near as possible, in latitude 34° and longitude $78^{\circ} 30'$, thence its direction is due

south-east to latitude $33^{\circ} 40'$; it then takes a bend easterly, and follows that latitude as far as Noh, in longitude $79^{\circ} 50'$. The mountains to the north-west of the first long reach are of no great apparent elevation. In July there was very little snow to be seen, and only on the very highest portion, or the main range which, nevertheless, is from 18,000 to 19,500 feet high; the highest peaks being 20,000; but the level of the lake being 13,931 feet above the sea, detracts considerably from their altitude. The terminal knobs of the spurs from the above range lie close on the edge of the lake, rising to the height of 600 to 1500 feet, generally terminating precipitously; and the lake, I should imagine, is excessively deep in such places. It would be a most interesting scientific enquiry to sound, with the aid of some portable kind of boat, the depth of this lake. To the south-west a high range runs parallel to the lake, some of the peaks on which attain an altitude of 21,500 feet; this range terminates in a peak above, and to the east-south-east of Tankse, which is 20,003 feet.

The above fine line of mountains, covered as they are with perpetual snow, and their ravines terminating above in small glaciers, form a fine boundary to this valley on the south. The southern watershed follows the lake very closely as far as Ote. It there extends further south, and between that place and Pal several very large lateral ravines descend into it, all with the usual broad, dry, gravelly beds; the largest of these are the Algrong, Tengun, Kiam-Surpo loombas, or valleys. On the northern shore, beyond the very large valley of Chang-Burmah, which finds its exit at the Ote plain, there is another, the Dal-Loomba, that drains the considerable tract of 150 square miles; the silt carried down from this has narrowed the lake very much, forming a low point jutting out into it, and has contracted the waters to a quarter of a mile in breadth. Altogether the mean breadth of the second lake, "Tso Nyak," or "Middle Lake," is much less than the first or true "Pangong." Wherever a tributary ravine joins the shore there is grass, scanty, as a rule, and of a very coarse kind. At Ote it is much richer, especially in the vicinity of the stream that unites the two lakes. On both banks of the second lake wood is found in plenty, growing luxuriantly in places. At Algrong and Numkum it formed a scrubby jungle; but on the northern shore, at Silung, it was met with no more, and the only fuel was a stunted plant, which throws out a good deal of woody root, and is found all over the country; and I never found a scarcity of it even up to 18,000 feet in the Chang Chùngmo, save where the ravines were very rocky. Descending from the small ridge between Paljùng and Pal, the extensive plain near the latter

comes in view, bounded by low spurs on every side, save the east, where a conspicuous peak rears its head; a small stream winds its way through the eastern side of the "Maidan," and joins the lake, being the only one on the northern shore that does so.

Three and a half miles beyond Pal the second lake ends, and a small stream is found flowing into it through half-a-mile of sandy flat ground, beyond which is another lake, called Tso Rum, having a length of about four miles; after crossing again some flat ground, Lake Tso Nyak (the second) is reached, connected, as before described, with Tso Rum below. Near the northern shore of this last is situated the small village of Noh, a short distance up a tributary from the north. This place I much wished to visit, but could not manage to accomplish it. On the northern shore of Tso Nyak, at intervals, a ridge of sand and earth runs parallel to the line of beach; at first I attributed this to the action of waves, but observing the large proportions of these banks in some situations, and at last seeing the ridge quite 6 feet high, and, moreover, that the bank had been fairly turned up, as if with a gigantic plough, I was puzzled to account for such an appearance; and on questioning the guides, then learnt that during winter, when the lake is frozen over hard, the water naturally accumulates under the ice, and, flowing westward, can find no exit. When the pressure becomes too great it tears up the frozen earth on the shore, and, liberated, flows over the surface of the ice. I give a slight sketch of a section through one of these banks, showing the old surface grass still growing on the perpendicular face of the upheaved ground, which, of course, is on the inland side. On measuring this I found it an inch or two over 6 feet. I noticed, also, that the banks were higher and better developed on the western curves of the bays. During summer, evaporation, no doubt, carries off a great amount of the surplus water that drains into it; but in the winter this must cease, and, with its upper casing of ice, the water, to free itself, tears and roots up the banks in the curious manner above detailed. During the whole time I spent on the shores of the Pangong, the only animal I saw was the kyang, or wild ass of Thibet; a few couple of these were grazing on the grassy maidans of the northern shore. Of the birds, geese were plentiful in the stream between the first and second lakes, and I saw many young broods. The Brahmini goose, teal, a red-headed diver with white body, and a very black plumaged duck, made up the water-birds.

There was a great scarcity of smaller birds; a sand-piper and wag-tail were occasionally seen on the shore. The large fish-

eagle was plentiful at Ote, attracted there by the fish which are seen for the first time in the slightly brackish water, flowing out of the upper lake; this lake is full of them,—they much resemble the tench in shape and colour, only somewhat longer in the body, and are covered with slime like those fish. I had fortunately brought a rod, and had near Num Kum, in deep water under the rocks, a very good afternoon's sport, catching some five-and-twenty; they ran about a pound in weight—the largest I caught being about 4 lbs. These fish formed a welcome addition to our food as long as we remained on the lake. I supplied my old Bhut Moonshie and some of the guard with hooks and lines. They became fierce fishermen, and brought in good bags. It is a fine sight to see the lake during a storm, when a good strong wind is blowing down a long extent of its surface, and dashing the waves, which rise to a considerable height, against the hard rocky shore. I had the fortune to see its surface in this state one morning; and sitting down, watched the waves rolling in, and Pangong waves brought up thoughts of beaches in old England. Though the country is so barren, the lake has its beauties in the varied tints of surrounding hills and mountains, and the rich deep blue of its waters, becoming quite of an emerald-green colour as they shallow near the shore. During the summer months the lake is quite deserted, and we did not fall in with a soul the whole distance up to Pal, or we might not have got so far. At that time of year the flocks of shawl-wool goats, sheep, and yâks, are grazed in the higher valleys on the young rich grass that springs up in some places after the snow has left the ground. During winter they are brought down to the level "maidans" near the lake, and Ote, I was told, becomes dotted with black "Champa" encampments. Snow, they say, never lies long at Ote, though the lake freezes all over very thick, and the degree of cold must be very considerable. The Champas or Changpas, who spend the winter on the lake at Ote, come from both Noh and Rudok. The said plain is a disputed piece of ground, the men of the Pangong district claim it; though, judging by the site of an old fort standing on a low rock on the north-western side of the plain, I should say it undoubtedly belongs to the Shassan authorities, by whom it was built years ago: proximity of Leh and greater part of the Thanadar there, places it in the Kashmir Rajah's territory. Walls of stone and earth are built up as a protection for the tents against the wind, and, to render them still snugger, I observed that the interior floor of their huts had been dug down to a depth of 3 feet, which must make them warm abodes.

I found the summer winds of this country cold enough.

What the winters are like I can well imagine. The amount of comfort in a tent, on the edge of a frozen sheet of water stretching for miles, must be a very minus quantity. During the whole period of my sojourn there in August, 1863, the weather, with a few solitary fine days, was miserably cold,—nothing but cloud, sleet, and rain. I may have seen it under disadvantageous circumstances, and I trust at times it does enjoy a little warmth and brightness. On the 1st of August we reached Paljung, and in the afternoon of that day came in sight of the first natives we had seen, viz., three men driving some yâks in our direction. They saw us at the same time, and turned and bolted: we followed, but failed to overtake them, it being about two miles to the point they had rounded. They had disappeared up some lateral ravine out of sight; our approach was, therefore, known to the Rudok men. It rained in torrents during the night. Camp was pitched at Paljung, where a long broad nulla-bed came down to the lake, and a low long promontory ran from the hills on the north out into it.

Our road next day, on towards Pal, lay over this, it being a very long round to follow the shore under the cliffs. From the low pass the broad dull green plain of Pal was seen, and on its western side we discovered the black tents of a small Tartar camp. As our approach was now certainly known to these people, we bent our steps there. Three men came out to meet us, and turned out very mild individuals, one being a Lhama or priest. Their dogs, of the large Tibetan breed, were much more noisy and furious at the intrusion of strangers, and were not to be reconciled until long after the tents were put up. These Champahas informed me that one of their number was about to ride into Noh at once, to give the news of our arrival and have it thence sent on to Rudok. I instantly set my Bhut Moonshie down to write a letter to the governor of the place requesting that he would raise no difficulty to my paying a visit to the place, and see its monasteries. The next two days I remained at Pal, for the hills were buried in dense cloud, and a good deal of rain fell, so that I was unable to proceed with my survey work in an eastern direction; on the third day the Zimskang of Rudok rode in with some twenty followers, and pitched his tents on the other bank of the little stream, and came over at once to see me. He was a native at Lhasa, a short, stout, jovial fellow, and brought a letter from the Governor of Rudok, and a white scarf, together with a present of two damuns (bricks) of tea, and some sheep and goats for my men. The letter was then read by the Moonshie, and was to the effect that it was not in his power to give me leave to visit Rudok, as he had strict orders from his superiors in Lhasa to

prevent foreigners crossing the frontier, and that it would eventually be known if he permitted it. He added that he could not use force to prevent my further progress; but he trusted I would not lose him his appointment by so doing, and that I would accept the presents as a sign of friendship. Having received orders not to bring on any collision with the Chinese officials, I had to give up the idea of seeing Rudok; but I held out for one more march towards the place, and gained my point, but not before showing some anger at their absurd wishes.

The Zimskang again came over, after my dinner, about 9 o'clock at night, to beg I would not proceed any further; but I said they must abide by their first agreement. The afternoon of that day I was enabled to ascend the limestone mountain, east of camp, and fix my true position: the range around Rudok, and the eastern end of the lake, were also again visible, and I was enabled to get intersections with other rays. The 5th broke, fortunately, clear and bright, so I started early along the shore of the lake in direction of Noh, my friend the Zimskang stuck to me like a leech, the whole day, with a few of his men; and a curiously dressed rabble they were, with their enormous flat mushroom-shaped hats, and all mounted on little shaggy, but sturdy ponies. They were all very jolly and amiable. I made no secret of my work, and showed and explained the map of the lake to him, which he thoroughly understood. I have found the people of Thibet far in advance of those of Hindustan as regards drawings, and what they are meant to represent. At a small hill called Tobo Nokpo—whence I had promised to return the previous day—I fulfilled my agreement, evidently to the great pleasure of the Zimskang, who was now more pleasant than ever, and thanked me with many salaams. On the 6th August my tents were struck to leave Pal, and the Rudok men did the same. I was invited over to their tents previous to starting, to partake of a parting cup of salted tea, churned with butter, which is always kept simmering on the fire; it is by no means a bad beverage when made with good fresh butter. I gave him a few presents and we parted. At the eastern end of the Pangong the hills somewhat decrease in altitude, the highest lying to the north of Noh. Looking in a direction due east from the higher points I ascended, the country appeared flat but undulating, and I observed in the far distance two or three pieces of water; these may turn out to be connected with Pangong Tso, probably bounded by steep sides, which were not discernible at twenty miles, they may extend for some distance; the breadth of this high region was considerable, and extended up to a snowy

range that rose suddenly on the south. The more level surface was not bounded by any mountains, and was seen stretching to the horizon.

The morning we left Pal was raw, cold, and cloudy; the road lay north-westerly for some distance over the dead level plain, that showed distinctly it had once been covered by water, for dead fresh-water shells are seen for some way; we then rose from it over a long, very gradual slope of some three miles, which at last contracted into a ravine, bounded with very low hills. The little camp of Champas continued their march with us, and had we been one day later coming into Pal we should have missed them altogether, and gone straight into Noh without meeting a soul. Nearly all their worldly goods were carried on sheep, only a few articles carried on the ponies they rode. The women drove the former, and, in fact, did more in the packing, unpacking, and pitching of the tents, than their lords and masters; after which they were sent on to the hill-side to collect the roots of a low shrub, having a scent like lavender. One of the Champa girls was very nice-looking, and wore a peculiar head-dress which is not seen on the Ladakh side. The usual narrow fillet of cloth worn by the Ladakh women was treble the usual width, and covered with torquoise and silver ornaments; near the attachment at the forehead was a bar of silver set with small torquoises, pendant from which, so as to lie on the forehead, were a number of silver coins attached by short strings of coral beads; the effect was very good. I had the young lady brought over to my tent, where she sat for her portrait, and was delighted at the drawing made of her.

The encamping ground was called Tobo Ruberu, and was a level piece of green grass, with several good streams of water flowing across, for, curious enough, the higher ravines of the country have plenty of water, but these are all absorbed a few miles down in the sand and gravel of the broad water-way. The valley was here high, broad, and nearly level; the mountains were of no great elevation above it, not more than 3000 feet, the lower slopes falling gradually from them into the valley, which was patched with furze of stunted growth and plenty of good grass. The morning of the 7th broke clear, sunny, and bright, with a fresh breeze; we started early, and gradually ascended the valley to the pass in our front, called the Dingo La, 16,270 feet. On the top the ground was nearly level, expanding into wide, open ground to the north; on the left rose a hill, about 1000 feet, which I determined to ascend to obtain a view over the hills and country around. Walking a short distance up this, a small tarn was seen in the centre of the level ground north of the pass, which had once evidently

extended over the greater part of the area. Scattered plants of rhubarb are here seen, but very tough and acid. The rocks were all of limestone formation, with a strike nearly east and west. I found no fossils; but it resembled in appearance the Palæozoic rocks of Dras, &c. I obtained from the peak a fine view, but could see no more of the eastern end of the Pangong near Noh, on account of a dense haze in that direction. I was much disappointed, and could only fix a peak or two looming up through the mist. My own camp and the Tartars had gone on, and I quickly followed them down the valley. This was very characteristic of these regions; spreading out into a broad, gravelly plain, on the left side of which was a sharply-defined scarp, showing its general level had been uniform. This plain forms the head of one of the branches of the Dal Loomba.

We parted with our Champa friends at a place called Chulpan, where they encamped to graze their goats and sheep for a few days, while we proceeded on along the side of the hills of the right bank, rising gradually to a low pass called Pa Luen, and descending on the other side to another tributary of the Dal Loomba, which at this spot branched into three broad arms that penetrated into the mountains on the north for some eight miles. The longest of these valleys had a direction north-west, and up this our road to the Chang Chûngmo ran: no water was here to be found, and it was not until we had proceeded another two miles that water was found in the bed of the ravine. Where we halted fuel grew in plenty—the yellow-flowered Tibetan furze, differing slightly from the European in not being quite so thorny. The valley was still broad, but the hill-sides descended into it with steeper slope; it was here called Drukter. When on the Sa Lam, a horseman was seen riding down the valley from the north, who joined us; he had come from an encampment up the valley, and said he was sent to escort us on to the pass ahead. Our movements were therefore well known, though we should not have supposed a human being to have been within miles; but the Champas were evidently on the watch, and espied us the moment we topped the pass of Sa Lam. Between camp and the Deenjor La the valley bore the same character, save that the broad gravelly bed was covered with a luxuriant growth of furze, this swarmed with hares, which got up in all directions, and I had some good shooting. The Deenjor La was reached about 10 o'clock; I found it by boiling-point thermometer to be 17,465. The rise was gentle the whole way, and fell in like manner into the valley on the north. As I came up to the usual pile of stones on the crest, two fine *Avis ammon* came round a spur to the right, at about 200 yards' distance. I managed to get a little

nearer, but missed them. A fine mass of hill rose to the south. Appearing easy and near, I sent the camp on to the stream below, and commenced the ascent; this was a good deal steeper and further than I had anticipated, proving to be 20,240 feet high.

The labour was rewarded, for from the summit I obtained a splendid view, and did a large amount of work; massive snow-beds still covered the top, and the wind was bitterly cold. The mountains to the south of the Pangong were well seen, with the great snowy range near the Indus beyond Rudok; and I still longed to go on in that direction. Up the mountains to the south and west, there was a fine view—of a country, bleak, naked, stony, and inhospitable. Only in a tributary of the great Chang Burma Loomba—whence was a way to Ote—was anything green; a little grass and furze there skirted the stream. Work being finished we were soon down again. It was a bitter cold evening, but the camp was in as sheltered a spot as we could find, and there was some good grass here for the yâks. The valley below camp took the usual configuration, and ran towards north-west, with a bed about one-fourth of a mile broad; at about three miles we reached the confluence of a large valley from the north, and up this I determined to proceed, and thence ascend to Kiepsang trigonometrical station. Several kiangs were here seen, and up the valley numerous Tibetan antelope. After marching up the gravelly wide hill for five miles—whose main tributary turned to the east and ended in an extensive elevated plain, on the surface of which lay some large snow-beds—we were rather at a loss to find water. I took the eastern branch, while the yâks and servants proceeded up the western (the Nertsè Loomba), towards a patch of green grass, where I thought water would be found, and this proved to be the case. From this the staff on the top of Kiepsang was visible, and a very delightful little pull up it looked. I followed the eastern branch to a low pass, which overlooked a narrow gorge that terminated a short way down on another high level plain. There was no track of any kind to be seen here, and my guides told me that the country on beyond was grazed over by a nomad tribe, called Kirghis, who did not own allegiance to the Rudok authorities, that they were great thieves and robbers, and occasionally came to Tanksè to exchange their wool for grain, of which they had none. These are the people who wander over the plains, thence to Ilchi, and into a terra incognita on the east.

It was not until late that I got back to camp, going to bed with the prospect of a stiff ascent next day. I was up and off very early: at this hour it was very cold, the water of the little stream frozen hard, and the backs of the yâks were quite

white with the frost. I took the line of a ravine which led up to the ridge east of the Kiepsang staff; the ascent was most fatiguing over the loose angular *débris* that filled the steep bed of the ravine, whose waters were frozen into waterfalls of ice. In this ravine we put up from under a rock a hare so benumbed with cold it could not run, and it was knocked over with a stick by one of the coolies, to his great delight. On reaching the bridge there was a long pull up to the pole, but the view recompensed all the labour to legs and lungs; the ascent was 3200 feet, the peak being 20,035, while the camp below was about 16,800. Bleak wastes of hill and wide dry drainage-courses met the eye to the north-east, backed by some high mountains, whose loftier peaks were covered with snow, and threw down some glaciers. To the south the great tributary of the Pangong, the Mipal Valley, could be followed for many miles; high, rugged, angular mountains bounded it on every side. It was very very cold, and I could scarcely do my work or hold the pencil; the clouds were gathering up fast, and before I left the peak sleet had begun to fall. I got under the lee of the ridge for breakfast, and made a brew of tea in the boiling-point thermometer-pot, of which I gave a cup all round to my men, and then descended on the western side into the valley below; by skirting the hill-sides, down into the ravines, and over spurs, we reached by evening the Kiung Gang La, 17,259 feet, on the boundary of the Kashmir and Rudok territory.

At this pass are stationed, throughout the summer months, a guard of a few Rudok men; these we now met, and they were chaffed by my Tankse coolies for thus being taken in rear; but they were very good-humoured, and said they were now off for their homes, and left that day with their ponies, black tent, tea-churn, &c. We saw a good many antelopes during the day. The next morning we proceeded down the ravine to the north, which was grassy for some way. The coolies, who had gone on with the breakfast things, came upon seven wild yaks, who went off down the valley, and were not seen again; they were, I believe, very wary: great numbers are to be seen later in the season, when they are driven out of their higher haunts by snow into these lower grazing grounds, which were covered with their traces. They occupy this part of the country from about the end of October until March, the larger number roaming away into the high plains on the north, though some remain throughout the year in the neighbourhood of Pangong, but I do not think are met with south of it. Numbers of hares were seen, and I bagged a couple for the pot.

Near this place I met Mr. Turnor, an English traveller, who, when I told him whither I was going, said he would accompany

me. He had been searching for the pass by which M. Schlagintweit had crossed towards Ilchi; but the natives with him (for he could not speak Hindustani) had brought him in this direction, quite a contrary point of the compass. The valley ahead of us appeared to end at about six miles distant, and thus it had been sketched in on the rough reconnaissance I had; so the next morning it was determined to leave the camp where it stood, and go on ourselves to the main ridge of the valley and return by evening. Plenty of woody-rooted wild lavender, or rather a stunted plant with the like scent, grew around, but grass was very scanty—only in two or three spots was found barely sufficient for the yaks. A few large patches of snow still lay on the ground; these (for the hill-sides were now quite bare of it) were the remains of deep drifts formed by the winter winds. I could not spare time to proceed any farther; I had much work to finish in the rear, and some high points to ascend, which the early snowfalls would shut up for the season. I much longed to explore, but could not do so. Mr. Turnor went on beyond for two days, and gave me afterwards a sketch of the ground. It appeared that for some ten miles further the open valley turned sharp south, and disclosed a long piece of water like the Pangong, but the mountains shut out the end of it: nor did he ever get so far as the edge, to tell me whether it was fresh or salt; so this may be, for all we know, another rival to the great Pangong Tso. Turnor saw six or seven miles of its waters, which he described as having a breadth nearly equal to that of the above lake.

Fine agates and cornelian are to be found in a small ravine, at the spot where the long southern spur from Chamkang H. S. abuts on the Kyamgo Traggar. I made a short ascent here, in order to obtain an extensive view over the country to the south-east. This presented the appearance of large, broad, level valleys, that might almost come under the designation of plains, the undulating ridges that divided them being of so little elevation. On the 15th August I encamped close to the hot springs of Kyam. These rise at the foot of the hills on the left bank; the alluvial plateau on the edge of which they are situated extends for about half a mile to the river, and ends in a low cliff. The water rises in several spots, covering a distance of about 150 yards long. The spring on the extreme west side is largest, and temperature the highest. The ground about is wet and swampy. From the north-west a large tributary here joined the Chang Chûngmo River, adding so much to the depth of its waters that it was a matter of difficulty crossing at the two fords below Kyam. The valley now lessened much in breadth, but the alluvial deposits were still well developed, and were cut into

a series of steps by the gradual falling of the lake, or the diminished waters of the river, or a drier climate commencing.

In the Gedmure Loomba was a green expanse of grass, with a rather severe ascent to a grazing spot called Boomzi; from this a high broad plateau extended to the pass, the line of watershed being so broad that it was difficult to assign its exact position. The high wide valley parted north and south, in first direction to the Ororotze La, 18,050 feet, only used by shepherds when taking flocks to graze in the lower courses of the Chang Chùngmo River.

I had now finished the whole of my work, and went on as far as Muglib, thence to Tangsè, where I paid my coolies: the men behaved very well; never had I any occasion to be put out by them. I returned to the Indus Valley over the mountains by the way of Kay La, 18,256 feet. The Kay Loomba River is fringed with grass and bushes for a considerable distance up, and at a height of 16,300 feet flows out of a lake about 400 to 500 yards long, of a very deep clear water. It owes its origin to a large landslip from the left side of the ravine, by which cause a very considerable portion of the hill-side has moved forward and been disrupted. The rock is granitoid, the same as the Chang La, and forms the main axis of the mountain-chain between the Indus and Shayok. From the lake to the pass the scenery was as wild as could be; near its source the ravine turned south, and was nearly level for some distance, ending amid a mass of scattered rocks, débris, and snow; large beds of which still filled the ravines and lay in patches on the summit of the ridge. The wind blew with great violence from the w.s.w., on reaching the pass, with that cutting, piercing, unsparing manner it does at these elevations. Behind the shelter of the rocks I boiled the thermometers, and then descended into the valley below.
